Claims as Filed

Claims

What is claimed is:

1. A polypeptide having the ability to bind CEA comprising a CEA binding loop having the amino acid sequence Cys-X_4-X_5-X_6-X_7-X_8-X_9-X_{10}-X_{11}-Cys (SEQ ID NO:3),

   wherein

           X_4- is Asn, Glu, or Met;

           X_5- is Asn, Leu, Met or Phe;
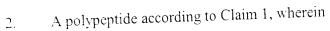
           X_6- is Asp, Gly, Ile, Lys Phe or Thr;

           X_7- is Ala, Gln, Gly, Lys or Thr;

           X_8- is Arg, Asn, Asp, Glu or Gly;

           X_9- is Gln, Gly or Leu;

           X_{10}- is Ala, Trp or Tyr;

           X_{11}- is Ala, Gly, His, Phe, Thr or Val;

2. A polypeptide according to Claim 1, wherein

           X_4- is Glu;

           X_5- is Asn, Leu, Met or Phe;

           X_6- is Asp, Gly, Ile, Lys, Phe or Thr;

           X_7- is Lys;

           X_8- is Arg, Asn, Asp, Glu or Gly;

           X_9- is Gln;

           X_{10}- is Trp; and

           X_{11}- is Ala, Gly, His, Phe, Thr or Val.

3.   A polypeptide according to Claim 1, comprising the amino acid sequence:

X_1-X_2-X_3-Cys-X_4-X_5-X_6-X_7-X_8-X_9-X_{10}-X_{11}-Cys-X_{12}-X_{13}-X_{14} (SEQ ID NO:1),

wherein

X_1- is Asn or Asp;

X_2- is Trp;

X_3- is Asp, Phe or Val;

X_4- is Asn, Glu or Met;

X_5- is Asn, Leu, Met or Phe;

X_6- is Asp, Gly, Ile, Lys, Phe or Thr;

X_7- is Ala, Gln, Gly, Lys or Thr;

X_8- is Arg, Asn, Asp, Glu or Gly;

X_9- is Gln, Gly or Leu;

X_{10}- is Ala, Trp or Tyr;

X_{11}- is Ala, Gly, His, Phe, Thr or Val;

X_{12}- is Asn, Gln, Phe, Ser or Val;

X_{13}- is Arg, Leu, Pro or Ser; and

X_{14}- is Leu, Ser, Trp or Tyr.

4.   A polypeptide according to Claim 3, having the amino acid sequence:

X_1-Trp-Val-Cys-Glu-X_5-X_6-Lys-X_8-Gln-Trp-X_{11}-Cys-Asn- X_{13}-X_{14} (SEQ ID NO:2), wherein

X_1- is Asn or Asp;

X_5- is Asn, Leu, Met or Phe;

X_6- is Asp, Gly, Ile, Lys, Phe or Thr;

X_8- is Arg, Asn, Asp, Glu or Gly;

X_{11}- is Ala, Gly, His, Phe, Thr or Val;

X_{13}- is Arg, Leu, Pro or Ser; and

X_{14}- is Leu or Tyr.

5. A polypeptide according to Claim 3, comprising an amino acid sequence selected from the group consisting of:

Asn-Trp-Val-Cys-Asn-Leu-Phe-Lys-Asn-Gln-Trp-Phe-Cys-Asn-Ser-Tyr (SEQ ID NO:4),

Asp-Trp-Val-Cys-Glu-Asn-Lys-Lys-Asp-Gln-Trp-Thr-Cys-Asn-Leu-Leu (SEQ ID NO:5),

Asn-Trp-Asp-Cys-Met-Phe-Gly-Ala-Glu-Gly-Trp-Ala-Cys-Ser-Pro-Trp (SEQ ID NO:6);

Asp- Trp-Val-Cys-Glu-Lys-Thr-Thr-Gly-Gly-Tyr-Val-Cys-Gln-Pro-Leu (SEQ ID NO:7);

Asn-Trp-Phe-Cys-Glu-Met-Ile-Gly-Arg-Gln-Trp-Gly-Cys-Val-Pro-Ser (SEQ ID NO:8); and

Asp-Trp-Val-Cys-Asn-Phe-Asp-Gln-Gly-Leu-Ala-His-Cys-Phe-Pro-Ser (SEQ ID NO:9).

6. A polypeptide having the ability to bind CEA comprising the amino acid sequence: X_1-X_2-X_3-Cys-X_4-X_5-X_6-X--X_8-X_9-X_{10}-X_{11}-Cys-X_{12}-X_{13}-X_{14} (SEQ ID NO:1),

wherein

X_1- is Asp, Asn, Ala, or Ile;

X_2- is Trp;

X_3- is Val, Ile, Met, Tyr, Phe, Pro, or Asp;

X_4- is Asn, Glu, or Asp;

X_5- is Leu, Phe, Tyr, Trp, Val, Met, Ile, or Asn;

X_6- is Phe, Leu, Asp, Glu, Ala, Ile, Lys, Asn, Ser, Val, Trp, or Tyr;

X_7- is Lys, Phe, Asp, Gly, Leu, Asn, or Trp;

X_8- is Asn, Pro, Phe, Gly, Asp, Ala, Ser, Glu, Gln, or Trp;

X_9- is Gln, or Lys;

X_{10}- is Trp;

X_{11}- is Phe, Thr, Met, Ser, Ala, Asn, Val, His, Ile, Pro, Trp, or Tyr;

X_{12}- is Asn, Asp, Glu, Pro, Gln, or Ser;

X_{13}- is Val, Leu, Ile, Pro, Ala, Gln, Ser, Met, Glu, Thr, Lys, or Trp; and

X_{14}- is Leu, Met, Val, Tyr, Ala, Ile, Trp, His, Pro, Gln, Glu, Phe, Lys, or

Arg.

7. The polypeptide according to Claim 6, comprising an amino acid sequence as depicted in Table 5 (SEQ ID NOs:37-107).

8. The polypeptide according to Claim 1, 3 or 6, wherein said polypeptide binds to CEA but does not bind to NCA.

9. The polypeptide according to Claim 1, 3 or 6, wherein said polypeptide has a K_d for CEA which less than 7 μM.

10. A method of detecting CEA in a subject comprising the steps of:
    a) detectably labeling a polypeptide according to any one of Claims 1-7;
    b) administering to said subject the labeled polypeptide; and, thereafter,
    c) detecting the labeled polypeptide in the subject.

11.   The method according to Claim 10, wherein said polypeptide is labeled with a radioactive compound.

12.   The method according to Claim 11, wherein said radioactive compound includes indium.

13.   The method according to Claim 11, wherein said radioactive compound includes technetium.

14.   The method according to Claim 10, wherein said detecting step is indicative of colon cancer, breast cancer, lung cancer, cervical cancer, ovarian cancer, stomach cancer, bladder cancer, pancreatic cancer or esophageal cancer.

15.   A method of treating a CEA associated disease comprising the step of: administering to a subject in need of treatment for such a disease a composition comprising a polypeptide according to any one of Claims 1-7 conjugated with a therapeutic agent effective for treating said disease.

16.   The method according to Claim 15, wherein said CEA associated disease is colon cancer, breast cancer, lung cancer, cervical cancer, ovarian cancer, stomach cancer, bladder cancer, pancreatic cancer or esophageal cancer.

17.   The method according to Claim 15, wherein said therapeutic agent is a radioactive agent.

18. The method according to Claim 15, wherein said therapeutic agent is a chemotherapeutic agent.

19. The method according to Claim 15, wherein said therapeutic agent is a toxin or enzyme.

20. A recombinant bacteriophage expressing exogenous DNA encoding a CEA binding polypeptide having an amino acid sequence comprising:

X_1-X_2-X_3-Cys-X_4-X_5-X_6-X_7-X_8-X_9-X_{10}-X_{11}-Cys-X_{12}-X_{13}-X_{14} (SEQ ID NO:1).

wherein

X_1- is Asp, Asn, Ala, or Ile;

X_2- is Trp;

X_3- is Val, Ile, Met, Tyr, Phe, Pro, or Asp;

X_4- is Asn, Glu, or Asp;

X_5- is Leu, Phe, Tyr, Trp, Val, Met, Ile, or Asn;

X_6- is Phe, Leu, Asp, Glu, Ala, Ile, Lys, Asn, Ser, Val, Trp, or Tyr;

X_7- is Lys, Phe, Asp, Gly, Leu, Asn, or Trp;

X_8- is Asn, Pro, Phe, Gly, Asp, Ala, Ser, Glu, Gln, or Trp;

X_9- is Gln, or Lys;

X_{10}- is Trp;

X_{11}- is Phe, Thr, Met, Ser, Ala, Asn, Val, His, Ile, Pro, Trp, or Tyr;

X_{12}- is Asn, Asp, Glu, Pro, Gln, or Ser;

X_{13}- is Val, Leu, Ile, Pro, Ala, Gln, Ser, Met, Glu, Thr, Lys, or Trp; and

X_{14}- is Leu, Met, Val, Tyr, Ala, Ile, Trp, His, Pro, Gln, Glu, Phe, Lys, or Arg

and where in said binding polypeptide is displayed on the surface of said bacteriophage.

21. The recombinant bacteriophage according to Claim 20, expressing exogenous DNA encoding an amino acid sequence selected from the group consisting of:
    Asn-Trp-Val-Cys-Asn-Leu-Phe-Lys-Asn-Gln-Trp-Phe-Cys-Asn-Ser-Tyr (SEQ ID NO:4), and
    Asp-Trp-Val-Cys-Glu-Asn-Lys-Lys-Asp-Gln-Trp-Thr-Cys-Asn-Leu-Leu (SEQ ID NO:5).

22. The recombinant bacteriophage according to Claim 20, expressing exogenous DNA encoding an amino acid sequence selected from the group of sequences depicted in Table 5 (SEQ ID Nos: 37-107).